REMARKS

Reconsideration is respectfully requested in view of the foregoing amendments and the following remarks.

Corrected drawings are submitted with the response as required by the Examiner. The corrected drawings include the changes approved by the Examiner and noted in the outstanding Action.

Claims 1, 10, 11, 30, 45 and 69 have been amended to clarify that the sensors are responsive to strain or forces applied to the sensors. Support for this amendment is found in the specification at page 8, lines 1-12 and page 9, line 15 to page 10, line 22.

Claims 1-5, 7-17, 19-23 and 29-70 were rejected under 35 USC § 102(b) as being anticipated by US RE37,065 to Grahn. The Grahn patent discloses a multi-axis force sensor that uses ultrasonic transducers and a target element spaced from the transducers. The target is embedded in a compliant supporting element that allows the target to move when a force or forces are exerted on the substrate. The transducers send ultrasonic pulses to the target and receive a reflected pulse. Based on the transit time, the transducers will calculate a change in the position of the target. By knowing the stress-strain characteristics of the supporting element, the strain force being applied can be calculated.

Note that the Grahn device measures displacement of the target caused by strain imposed on the compliant element. The compliant element and target must be embedded in or positioned with the monitored object to experience the strain. The Grahn ultrasonic sensors do respond to strain imposed on the sensors (contact strain on or deforming of the sensors), but only to changes in the position of the target relative to the sensors.

The invention relates to a strain sensor that relies on different components and different mechanisms for determining the strain in an elastomeric element. According to claim 1, the invention includes first and second pairs of strain sensors positioned on intersecting planes and deforming in response to force or strain on the sensors to generate a signal indicative of the force or strain applied to the sensors. The output or signal produced is the result of strain in the sensor, which is caused directly by strain in the monitored elastomeric material. The other claims of the application have this distinguishing recitation.

Independent claim 10 defines first and second sensing elements embedded in an elastomeric element that generate an output indicative of strain in the elastomeric element applied by contact to the sensing elements. Independent claim 11 defines a pair of strain sensors that deform in response to a force applied by contact to the sensors to produce a signal. Claims 30 and 45 recite methods that include providing sensor assemblies that detect strain applied directly to sensor elements of the assembly. Claim 69 recites a sensor assembly embedded in an elastomeric material having sensor elements that deform in response to strain in the elastomeric material transmitted directly to the sensor elements.

The sensors in the assemblies according to the invention measure strain in the monitored material through direct contact producing strain in the sensor elements. For further support, see the specification at page 8, lines 1-12 and page 9 line 15 to page 10, line 22. A sensor assembly in accordance with the invention can be embedded in a material to be monitored for strain in direct contact with the material. No target is necessary, no compliant supporting material is necessary, nor is knowledge of the stress strain characteristics of the elastomeric material necessary to operate the sensor assembly.

The cited Grahn patent, by contrast, discloses sensors that must first be embedded in a compliant material with a target. The package of compliant material may then be embedded in the material to be measured. The sensor elements of the Grahn device do not measure strain through a strain or force applied to the ultrasonic elements, but, rather, measure their respective distance from a target.

Grahn does not, therefore, disclose or suggest a strain sensor assembly as claimed.

Claims 11, 30, 45 and 69 further each recite a pyramid-shaped body that supports the sensing elements. This facilitates embedding the device in an elastomeric material by correctly orienting the sensors relative to one another.

Grahn does not disclose or suggest a strain sensor assembly having sensors mounted on opposed faces of a pyramid-shaped body. Grahn Figures 1a, 1b, 5, 7b, 7c, 7d disclose arrays of ultrasonic sensors mounted on adjacent sloped supports to aim pairs of these sensors at a common target. Grahn's sensors would not be mounted on opposed faces of a single pyramid body because the ultrasonic signals would diverge, rather than converge on the target. Grahn requires at least two sensors detecting the change in position of the target to arrive at

the multi-axis results. Thus, Grahn does not suggest the pyramid body of the present invention.

Claims 1, 10, 11, 20, 45, and 69 are allowable for at least the foregoing reasons. The dependent claims are allowable at least as depending from an allowable base claim.

Allowance of the pending claims is respectfully urged. The Examiner is invited to telephone the undersigned to resolve any outstanding issues or if a telephone call would be helpful toward expediting the case.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (Three Times Amended) A sensor assembly for use in an elastomeric material, the assembly comprising:

a first pair of <u>strain</u> sensors disposed along a first pair of respective planes that intersect, each of said first sensors deforming in response to a force in a first direction <u>applied to the sensor</u> and generating a corresponding output;

a second pair of <u>strain</u> sensors disposed along a second pair of respective planes that intersect, each of said second sensors deforming in response to a force <u>applied to the sensor</u> in a second direction and generating a corresponding output; [and]

wherein the force in the first direction is equal to the difference between the outputs of said first sensors, and the force measured in the second direction is equal to the difference between the outputs of said second sensors.

to assembly or sensor the invention. Also there is no (rotary) testing or measuring claimed but merely 1st 2nd sensing elements

10. (Twice Amended) A three-axis sensor assembly embedded in an elastomeric material, the sensor comprising:

a first sensing element <u>for</u> generating a first output indicative of a strain in <u>the elastomeric material in</u> a first direction applied [directly] <u>by contact</u> to said first sensing element;

a second sensing element <u>for</u> generating a second output indicative of a strain in <u>the elastomeric material in</u> a second direction orthogonal to said first direction applied [directly] <u>by contact</u> to said second sensing element; [and]

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wherein the sum of said first and second outputs is indicative of strain in a third

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direction orthogonal to both the first direction and the second direction.

11. (Amended) A sensor assembly embedded in an elastomeric material, said sensor assembly comprising:

a pair of first strain sensors disposed on first opposed faces of a flexible pyramid-shaped body, said first strain sensors <u>being deformable under a force applied by contact thereto for</u> detecting a force in a first direction; [and]

wherein said first strain sensors generate[, substantially in real-time,] corresponding output signals in response to the force in the first direction[, substantially in real-time,] and wherein the force in the first direction is generally equal to the difference between the output signals of said first strain sensors.

30. (Twice Amended) A process of embedding a sensor in an elastomeric material, the process comprising:

providing a three-axis sensor assembly including two pairs of strain gauges, a first pair disposed on first opposed faces of a pyramid-shaped body so as to [directly] detect strain <u>applied directly to said first pair of sensors</u> in a first direction, and a second pair disposed on second opposed faces of the pyramid-shaped body so as to [directly] detect strain <u>applied directly to said second pair of sensors</u> in a second direction; and

adjusting the aspect ratio of the pyramid-shaped body to a sensitivity of the three-axis sensor.

45. (Twice Amended) A process of embedding a sensor in an elastomeric material, the process comprising:

providing a three axis sensor assembly including first and second pairs of strain sensors, the first pair disposed on first opposed faces of a pyramid-shaped body[, and the second pair disposed on second opposed faces of the pyramid-shaped body] so as to detect strain in a first direction [substantially in real-time] <u>applied directly to the first pair of sensors</u>, and the second pair disposed on second opposed faces of the pyramid-shaped body so as to detect strain in a second direction [substantially in real-time] <u>applied directly to the second pair of sensors</u>; and

placing the sensor assembly in the elastomeric material when the elastomeric material is in an uncured state.

69. (Twice Amended) A three-axis sensor assembly embedded in an elastomeric material that measures strain forces on the elastomeric material, the sensor assembly comprising;

a three-axis sensor assembly including two pairs of strain sensors, a first pair disposed on first opposed faces of a pyramid-shaped body so as to deform in response to strain in the elastomeric material transmitted directly to said first pair in a first direction, and a second pair disposed on a second opposed faces of the pyramid-shaped body so as to deform in response to strain in the elastomeric material transmitted directly to said second pair in a second direction;

a printed circuit responsive to the outputs of said strain sensors to generate a corresponding signal indicative of the corresponding strain acting on the elastomeric material; and

wherein the sensor assembly is electrically coupled to the printed circuit.